tt+jets

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Motivation

- Better understand the tt production
  - Probe the theory in perturbative mode
  - Compare and tune MC generators
  - Constraint ISR/FSR
- Study the main background to many analyses
- Search for signs of new physics
  - Ex: tq resonances (tW'→ttq, tφ→ttq), stop production

What has been measured

- Normalized differential dσ/dN cross section
- Fraction of events without additional jets in a certain rapidity interval
- Production cross section σ(tt+jets)
- tt+heavy flavor production (not covered here)

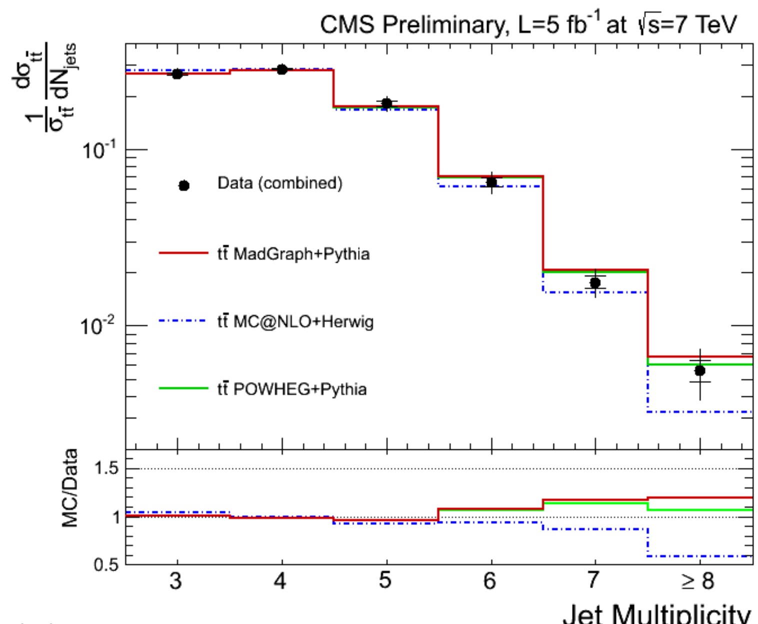
Measurement details

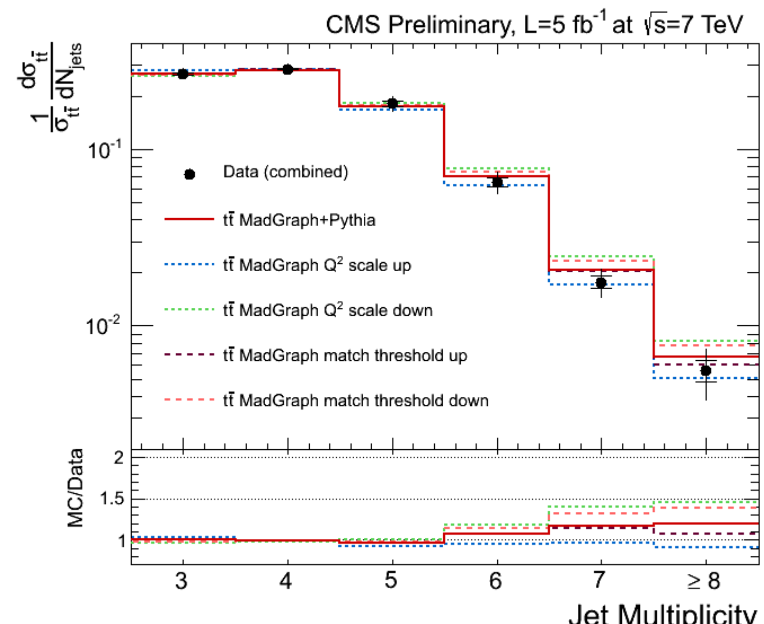
- Observed jet multiplicity has to be unfolded to the parton level
- Parton jets can be further associated to top quark decay products
- Cross section measurements have to be done in some fiducial volume
- To make the data/MC comparison more meaningful, look at differential cross sections

tt jet multiplicity measurements

- Normalized differential cross section dσ/dN
  - N: number of particle jets with pT>30 GeV, |η|<2.4

$$\frac{d\sigma}{dN} = \frac{1}{\sigma}\frac{N^i_{\mathrm{data}} - N^i_{\mathrm{bkg}}}{\varepsilon^i \mathcal{L}} \qquad \varepsilon^i = \frac{N^i_{\mathrm{rec}}}{N^i_{\mathrm{gen}}}$$





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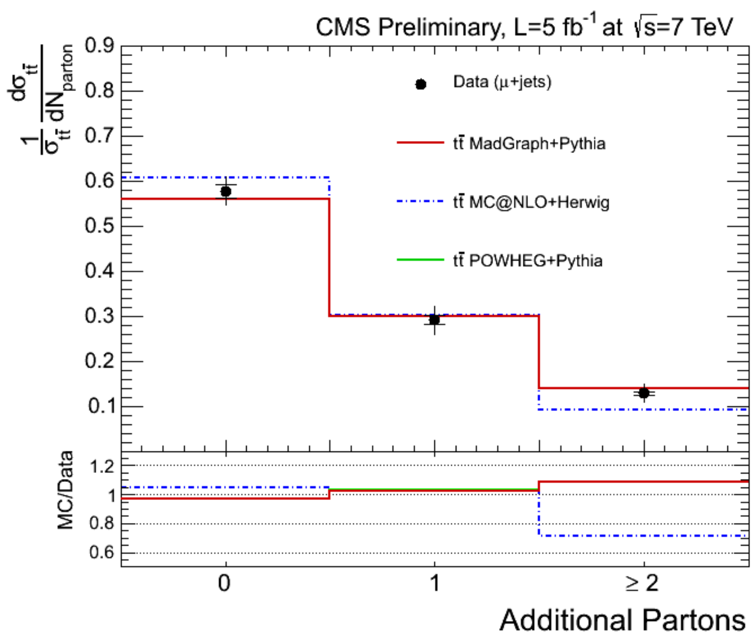
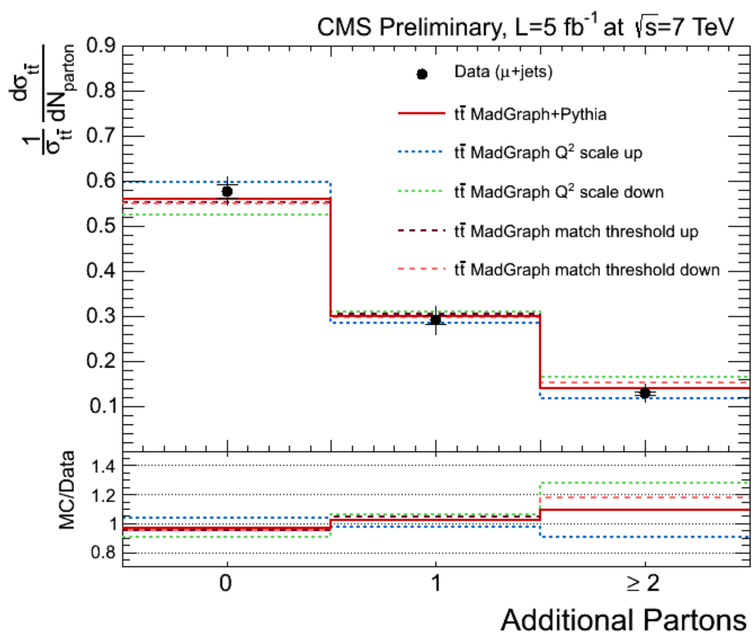
$t\bar{t}$ jet multiplicity measurements

- Normalized differential cross section $d\sigma/dN_{add}$
  - N_{add}: number of particle jets with pT>30 GeV, $|\eta|<2.4$ with $\Delta R>0.5$ to all top decay products





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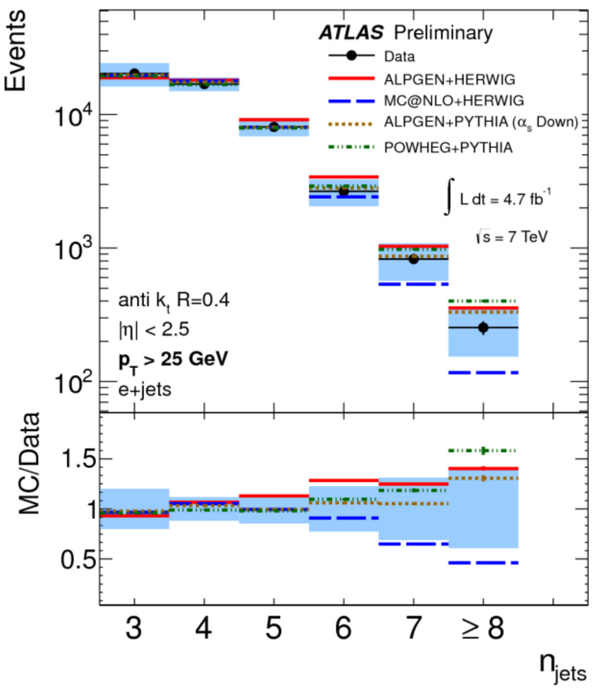
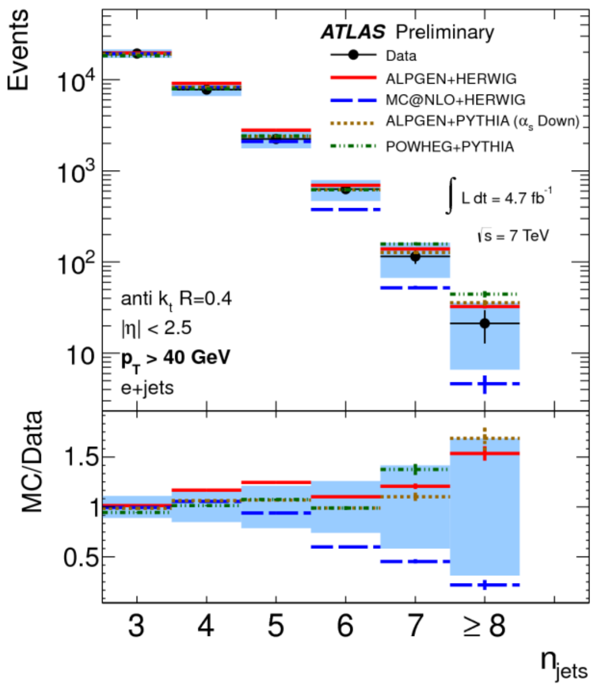
tt jet multiplicity measurements

- Normalized differential cross section dσ/dN vs parton jet pT cut





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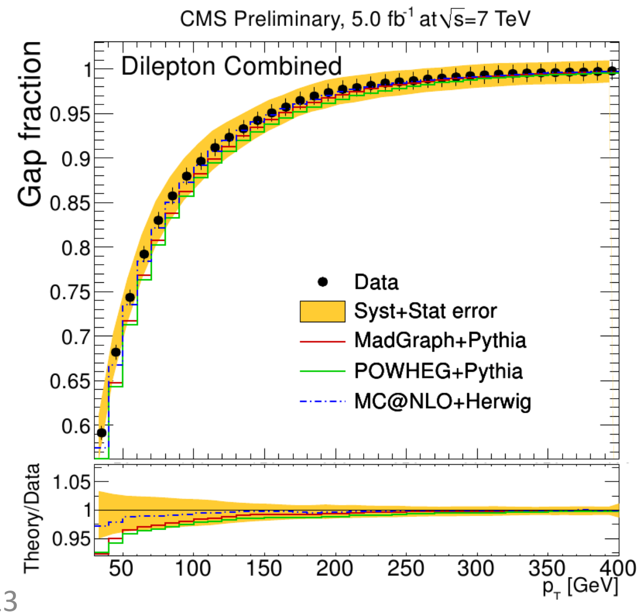
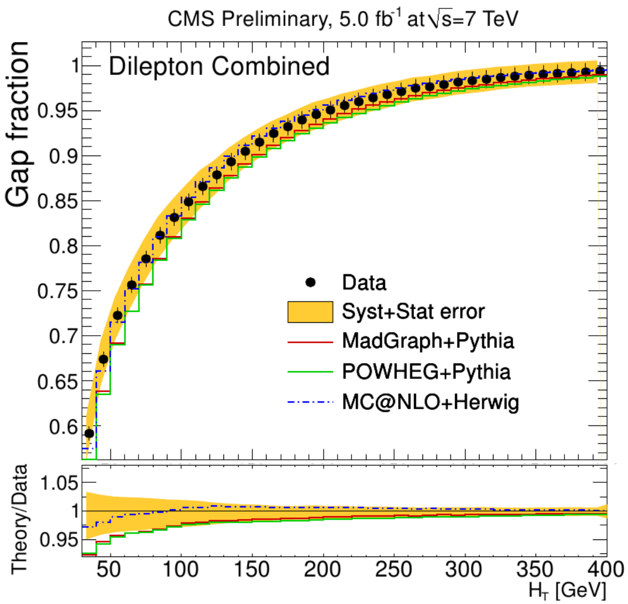
Gap fraction measurements

- Gap fraction vs additional jet pT and HT
  - gap fraction = fraction of events that do not contain an additional jet (unfolded to particle level)
  - “additional” = except two highest pT b-jets – dilepton channel helps!





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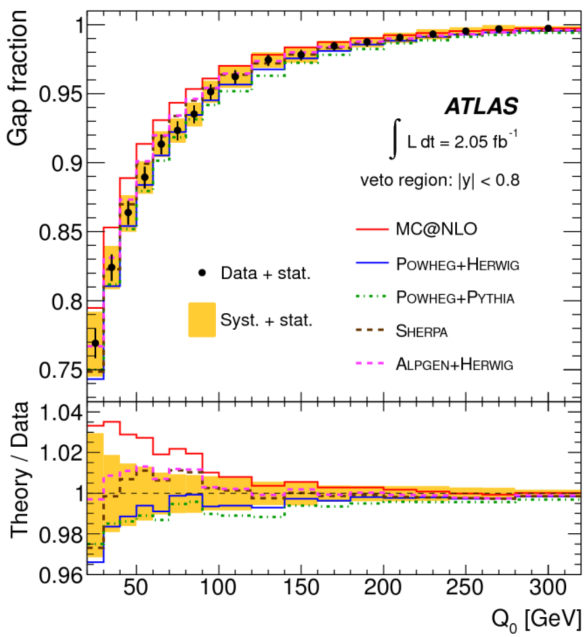
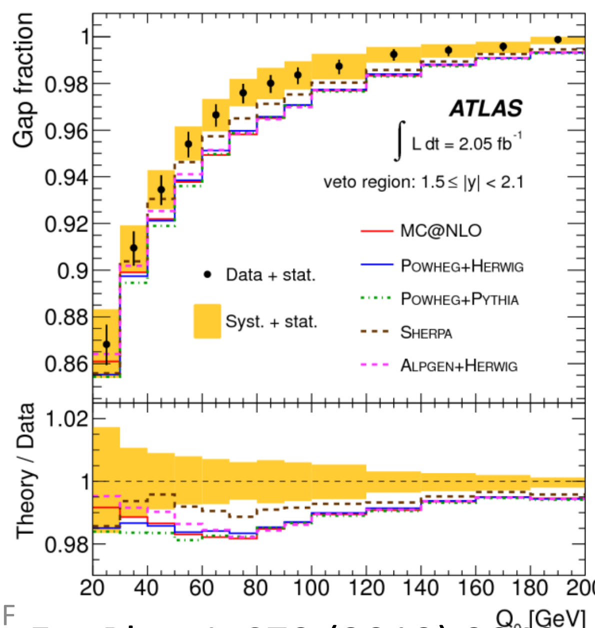
Gap fraction measurements

- Gap fraction in various jet rapidity intervals
  - what has been seen is that with veto in the forward region, agreement between data and MC is poor





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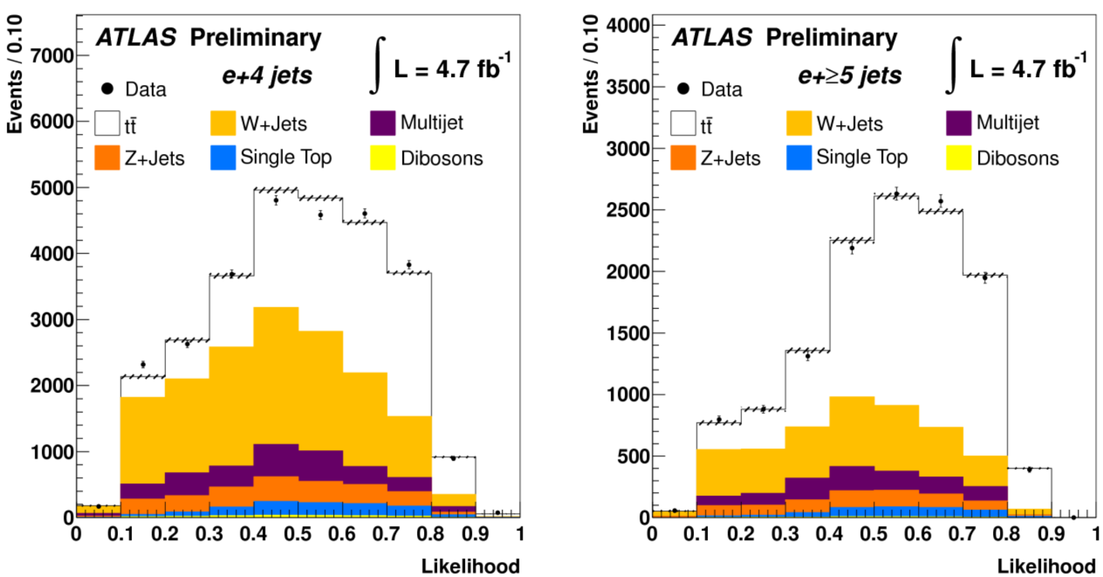
tt+jets production cross section

- Has been measured for two definitions for tt+jets:
  - Presence of particle jets not matched to top decay products
  - At least 5 particle jets
- Possible approach: instead of counting reconstructed jets and unfolding, construct kinematic likelihood templates for events with and without additional jets



σ(tt+jets)/σ(tt)=0.51 ±0.01(stat)±0.08(syst)

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Conclusions

- tt+jets production is being measured and results used in other analyses
  - e.g. rapidity gap measurements are used to constraint ISR/FSR parameters and reduce systematic uncertainties due to MC generators
- Want to measure differential cross sections
  - most helpful in constraining MC parameters and clarifying details of tt production
- Meaningful studies should include comparison of various MC generators / generator options